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BANG'S DISEASE

(INFECTIOUS ABORTION)

BANG'S DISEASE is widely distributed and results in serious losses to the livestock industry. It is caused by a germ known as *Brucella abortus*. The disease is commonly introduced into healthy herds by the addition of infected cows or infected pregnant heifers.

The act of abortion is its best-known symptom. Other symptoms are weak, though living calves, sterility, and retained afterbirths.

The germs may be in the uterus or the udder, in the generative organs of bulls, in certain lymph glands and joints, and in the intestines and other organs of newly born calves.

Diseased animals eliminate the germs in the fetus, afterbirth, and uterine discharges for limited periods, and in the milk for prolonged periods.

The malady appears to be commonly acquired through the mouth in feed and drink contaminated with the germs, by licking affected animals to which the germs adhere, contaminated mangers, or other objects. The skin and the membranes which line the eyelids may also provide a means of access for the abortion germ into the animal. Proof that bulls transmit the disease through the act of service is lacking.

There is no scientific basis for believing that abortion losses can be prevented or reduced by the administration of drugs or medicinal compounds.

The way to deal with an infected herd depends on how extensively the disease has spread, whether the animals are valuable from a breeding or producing standpoint, whether there are facilities for having abortion tests made, and whether provision can be made for dividing and maintaining the herd as separate units among which there is little or no communication.

This bulletin is a revision of and supersedes Farmers' Bulletin 790, Contagious Abortion of Cattle, and Farmers' Bulletin 1536, Infectious Abortion of Cattle.

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BANG'S DISEASE (INFECTIOUS ABORTION)

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BANG'S DISEASE, infectious abortion, contagious abortion, and abortion disease are different names for a livestock disease, especially prevalent in cattle, that causes heavy losses in the United States and most other countries. It has existed for centuries although for a long time its cause remained obscure. During recent years it has gained additional prominence and has become a matter of growing concern to those engaged in raising or handling cattle. As interest in the production of better stock has increased and as the long-distance shipment of animals has become more common, conditions have not only become more favorable for the spread of the disease but have made the losses which it causes of greater consequence to cattle owners.

NATURE OF THE DISEASE

Bang's disease has puzzled stock owners and has been the subject of much controversy among investigators. There has been a tendency to regard the act of abortion, its most usually observed symptom or manifestation, as the disease itself. Viewed in this manner it has been natural to suppose that the malady may commonly be acquired just before the act of abortion and that recovery has taken place when the generative organs show evidence of having assumed their normal condition. Experimental studies have plainly shown that this conception of the disease is erroneous and have at the same time revealed something of its true nature.

It has been determined that the act of abortion is merely one symptom or manifestation of the disease, a rather inconstant one in fact, and that abortion, when it occurs, is commonly induced by a diseased condition of the membranes through which oxygen and nourishment pass from the dam to the fetus. The diseased condition is brought about by the action of germs which may have invaded the uterus of the dam weeks or even months previously. If the gestation period

is well advanced before the membranes become severely affected the calf may be weak but living when expelled. When the infection becomes severe during the earlier months of gestation, the fetus is usually dead on expulsion (fig. 1). Whether the dam expels a dead fetus or a calf with sufficient vigor to survive is determined to a great degree by her ability to resist the action of these germs.

Although the act of abortion is the most readily observed symptom of the disease, it has been noted also that in affected herds (1) sterility, or barrenness, is commonly more or less troublesome; (2) animals give birth to calves which, although living, may be too weak to resist some of the more common ailments; (3) cows show a tendency to retain their afterbirths, and (4) a reduced milk production

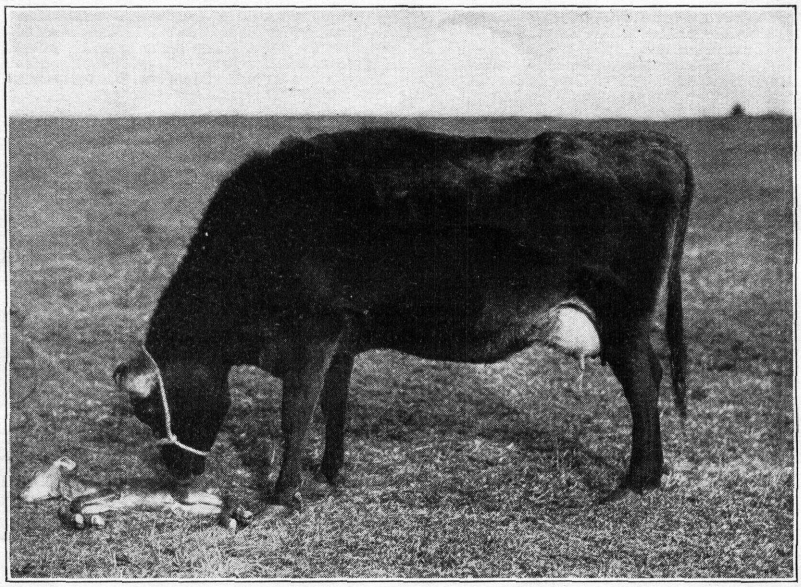

FIGURE 1.—A cow with her dead fetus. This abortion occurred during the seventh month of pregnancy. Cattle of all breeds and degrees of breeding may be affected.

is occasioned by the failure of animals to complete their normal gestation periods. Losses due to these conditions may equal or even exceed those represented by the number of calves that are born dead.

CAUSATIVE AGENT

European investigators recognized the transmissibility of the disease more than 50 years ago, but they were unable to ascertain the nature of the infection that was responsible. It continued to remain much of a mystery, so far as its causative factor was concerned, until Professor Bang, a Danish investigator, announced, in 1897, his success in cultivating from the carcasses of aborted calves a certain germ, which if introduced into the blood stream of healthy pregnant cows caused them to abort. This micro-organism he called *Bacillus abortus*. English investigators a few years later confirmed the work of Bang. During 1900 it was definitely shown that the

same type of infection could be isolated from aborted calves in the United States. The discovery of the abortion bacillus marks an important event in the history of the disease, and much credit is due its discoverer, since the cultivation of the germ necessitated the application of methods that were both unique and original.

Twenty-one years after Bang's discovery, Alice C. Evans, an employee of the United States Department of Agriculture, observed that the germ isolated and described by Bang bore an unusually close resemblance to a micro-organism termed "*Micrococcus melitensis*," discovered in 1887 by David Bruce, a surgeon in the British Army, when investigating a human disease in the Island of Malta. Although originally isolated by Bruce from human beings who had succumbed to the disease known as Malta, Mediterranean, or undulant fever, it was later discovered that the infection invaded goats and that the disease was commonly acquired by human beings through drinking the milk of affected goats.

Since the germs discovered by Bruce and Bang, respectively, were found to have many characteristics in common, it seemed desirable to consider them, as well as the abortion germ which affects swine, as belonging to the same genus. The term "Brucella" in honor of Bruce, the discoverer of the first type of the germs, thereupon came into use as the generic name. The different types thus became known as *Brucella abortus* (bovine), which commonly affects cattle; *Brucella abortus* (porcine), the type common to swine; and *Brucella melitensis*, the type found in goats and isolated by Bruce from human beings.

Before the discovery of *Brucella abortus* there were numerous theories as to the cause of abortions. Mechanical injuries, the consumption of moldy or smutty feed, and exposure to odors emanating from aborted calves were thought to cause it. Although such theories have been largely abandoned, investigators have determined that it is not always possible to demonstrate the presence of the *Br. abortus* in all calves that are expelled dead or immature, or in their membranes. Numerous types of germs other than *Br. abortus* have been cultivated artificially from aborted calves. Their significance as causative agents is, however, not completely understood, for while they have been repeatedly found in the organs and parts of aborted calves, their injection into healthy, pregnant cows seems rarely to cause abortion.

During recent years investigators of diseases have been engaged to a considerable extent in studying the effects of certain feeds or the withholding of certain feeds on the health of animals and the proper functioning of the different organs. The results of these studies have suggested that improper feeding may have some connection with abortion losses.

LOCATION OF BRUCELLA ABORTUS IN INFECTED ANIMALS

The act of abortion furnishes little information as to when the disease was contracted or when it will be overcome by an animal. The tendency on the part of the germs to multiply in the bodies of animals for long periods justifies the recognition of the disease as a chronic malady. Information as to the location of the causative

germs and the ways in which they are eliminated is important in the eradication of the disease. With an understanding of these factors one is in a favorable position to guard against the transference of the infection from diseased to healthy stock.

The fetus, fetal membranes (afterbirth), and discharges from the generative organs at time of aborting and for a variable period afterwards are usually saturated with the germs. Discharges shortly before the act may also contain the infection. These circumstances contribute greatly toward rendering the control of the disease most difficult. Probably in no other infectious disease of cattle does the affected animal eliminate so excessive a quantity of infected material during a brief period as does the aborting cow.

The aborting animal, moreover, is not alone responsible for scattering the infection. Infected cows, although they produce seemingly normal calves, may be as menacing to healthy stock as if they had aborted, because their afterbirths and uterine discharges may contain myriads of the abortion germs, a feature that until recent years escaped observation.

Only in rare instances have the germs been found in the genital tracts of cows for any great length of time after the dead or living calf has been expelled. Experimental tests indicate that they are seldom present in the discharges longer than 3 or 4 weeks although in rare instances they have been found nearly 2 months after the expulsion of the calf or fetus.

The udders of many infected cows, whether they abort or not, contain and eliminate the germs for a widely variable period. Investigators have never been able to understand or account for the wide variation that exists in the length of time that udder infection persists in different animals. Experimental work has indicated that the abortion germs may be present in the milk of some infected cows during all the rest of their lives after the malady is contracted. Other animals, however, recover from udder infection during the course of a few months or even weeks.

Since it has not been possible to prove that the germs commonly live in cows for any great length of time except in the udders and adjacent lymph glands, the disappearance of the germs from these organs probably signifies in most cases that they are no longer present in the animals. Furthermore, experiments have indicated that those animals which have ceased to eliminate the germs from their udders possess a marked degree of resistance to the affection. On the other hand, as long as udder infection persists, it appears to act as a source of infection for the pregnant uterus, although invasion of the latter organ may not uniformly occur. Unlike numerous varieties of germs, *Brucella abortus*, when present, does not appear to produce visible evidence of udder disease. The multiplication of the germs in this organ seems to be principally a provision of nature for the perpetuation of the infection.

In some instances the infection establishes itself in the generative organs of bulls and causes permanent injury to them, and it has also been proved that the seminal fluid of infected bulls may contain abortion germs (fig. 2). These facts are of considerable practical importance, not only because they reveal the limited value of sheath douchings as a means of rendering the bulls' generative organs free

from the causative germs, but also because they explain why bulls should be so handled as to prevent their discharges from contaminating premises accessible to stock free from abortion disease.

Newborn calves from cows infected with *Brucella abortus* may harbor the infection in their intestines and other organs for a brief period and therefore during this time are possible sources of infection to stock free of the disease. Experimental tests, however, have failed to indicate that the infection is eliminated by such calves for an extended period; consequently, minor importance is attached to the spread of the disease by them.

In rare instances the abortion germs have been detected, in cattle, in certain lymph glands other than those adjacent to the udder, and in the joints and the blood.

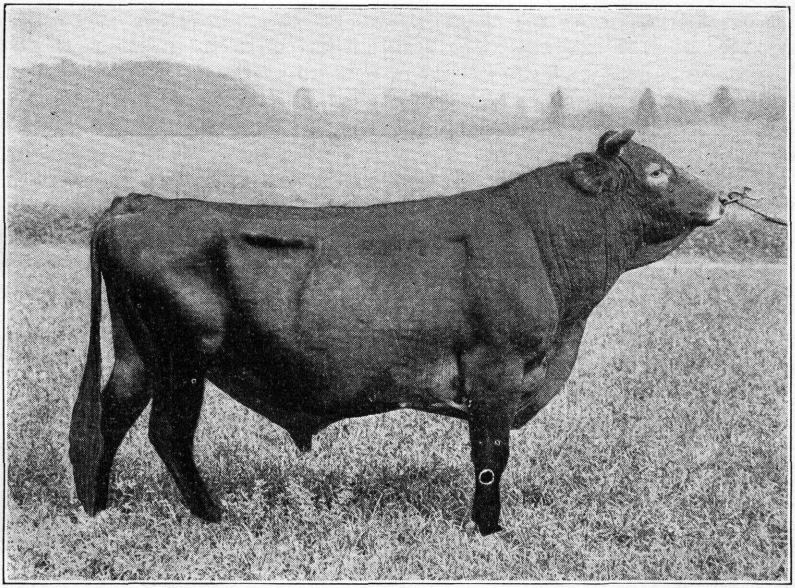

FIGURE 2.—A bull which proved to be infected with abortion germs, thereby destroying his value as a sire. The disease is rarely evident from the animal's physical appearance.

HOW AND WHEN THE DISEASE IS ACQUIRED

How animals commonly acquire the disease is a question that has engaged the attention of investigators since the discovery of its cause.

For a time it was supposed that the germs gained lodgment on the external genitals of cows and were conveyed through the vagina to the uterus, where they set up inflammation. It was believed that the transference of the abortion germs from the affected to the healthy animal resulted from contact with contaminated gutters or from direct contact between the healthy and the diseased animals. Spraying the tails and external genitals of cows with antiseptic solutions was considered advantageous as a control measure.

It has also been generally believed that cows and heifers commonly contract the disease at time of service. Bulls not themselves infected

have been considered capable of transferring the germs from affected to healthy cows by the soiling of their generative organs. This theory appeared to be so logical that its accuracy for many years remained unchallenged, but results of more recent experiments have failed to substantiate it.

Calves show marked resistance to the disease although it was at one time thought that they might carry the infection in their bodies from birth to maturity. Studies of this question have supplied, thus far, only meager evidence to support that belief. The age at which young cattle lose their immunity has not been determined.

The readiness with which susceptible, pregnant cows and pregnant heifers may be infected through the digestive tract by feeding them discharges from cows which have recently aborted has strongly indicated that the malady is commonly acquired by way of the mouth. The disease has not only been produced experimentally in pregnant cows and heifers through this channel, but unbred cows have likewise been made carriers of the germs in their udders and milk. Not only has it been possible to infect cows readily in this manner, but it has been accomplished when the quantities of material fed, containing the germs, have been surprisingly small.

More recent experiments have revealed that there are two other ways that had formerly received but limited consideration, by which the disease may be transmitted to susceptible pregnant cows and heifers. Experimentally the disease has been transmitted to susceptible cattle by depositing a small quantity of *Brucella abortus* infection on the mucous membrane surrounding the eyeball and also by its application to the skin whether the latter was slightly abraded or intact. Although the spread of the disease under natural conditions by these ways lacks definite proof, it seems probable that materials contaminated with *Br. abortus* from infected cows occasionally gain access to the eyes of susceptible cattle or come in contact with areas of their skin and thus transmit the disease.

SYMPTOMS

The symptoms or signs that denote the presence of Bang's disease are rather inconstant and indefinite. The act of abortion is probably the most widely known and most readily observed, but it may easily be misinterpreted, since not all cows that abort are affected with the disease. Its prompt recognition in diseased herds is, moreover, rendered difficult because of the fact that many animals which acquire the disease never abort.

When the act of abortion occurs it may be preceded by changes commonly observed in cows approaching normal parturition, such as enlargement of the udder, slight swelling of the external genitals, uneasiness, and straining. Discharges from the genital tract preceding the act may occasionally be observed. The fetus may be expelled during any stage of its development. If the fetus is small, the act of abortion may occur unobserved.

When the dam aborts during the early months of pregnancy the afterbirth, not being firmly attached to the uterus, is usually expelled with the fetus, whereas during the later months of gestation its retention is common. Some fetuses may be born alive but too weak to survive more than a day or two.

Fluid or semifluid materials are eliminated from the genital tracts of aborting animals for a variable period following the act. The length of time that such discharges continue to be expelled depends on both the severity of the disease in the uterus and the manner of treatment employed. The discharges are usually brownish or yellowish brown, but may not differ greatly in appearance from discharges in cases of retained afterbirth not caused by the abortion germ. The afterbirth, when expelled or removed and examined before becoming markedly putrefactive, frequently shows changes that aid the trained observer in recognizing abortion disease.

Areas of the membrane that are normally thin and translucent may present a leathery appearance or be studded with small elevations, and the borders of the cotyledons (tumorlike enlargements, where union between dam and fetus is established), may consist of a cheeselike substance. The irregular surfaces of some of the cotyledons may likewise be occupied by this cheeselike material. The absence of these changes, however, does not necessarily indicate that the abortion germ has not been active.

Sterility (barrenness) is usually a troublesome factor in herds into which the disease has gained entrance. Although cows which have aborted may conceive at the first service, it is often necessary to breed an aborter repeatedly before conception takes place. Heifers as well as the aborting cows in such herds may show irregularities in breeding.

Because sterility frequently causes more or less trouble in herds free of abortion disease as well as in infected herds, it does not constitute definite evidence that the abortion germ is involved. The retention of the afterbirth likewise does not afford definite information as to the presence or absence of the disease, since that was a frequent calving complication in this country before infectious abortion became widely prevalent.

Although none of the symptoms mentioned furnish definite knowledge as to the presence or absence of the malady, they may well be regarded with suspicion and as justifying prompt action. This applies particularly to the act of abortion. Until a definite diagnosis can be reached it is wise to infer that an aborting animal is affected with the disease and to proceed in accordance with that inference.

DIAGNOSIS

Cattle owners have shown unusual interest in the diagnosis of Bang's disease, since it plays such an important part in eradication programs. There has been some skepticism about the reliability of the agglutination test, the one commonly used. Before the discovery that the infection may establish itself in the udders of cows and be eliminated in the milk for long periods of time, there were reasons for doubting the accuracy of the test. The fact that many reacting animals have produced living, vigorous calves has sometimes been erroneously regarded as indicating that the test is unreliable. It is now well known that the results of the agglutination test throw very little light on whether tested animals will abort, but they do give a reasonably accurate idea whether the animals harbor the abortion germs in their bodies. It is true that many animals recover

from Bang's disease and cease to be carriers of the abortion germs after once having contracted the disease, and also that the test fails to differentiate sharply between present and past infections. However, it is possible to distinguish with considerable accuracy, between present and past infection, by the intensity of reactions.

Experiments have shown that after pregnant heifers were fed material infected with *Brucella abortus*, reactions in some cases were slow in developing. In some instances a period of between 3 and 4 months was required before a positive diagnosis by the agglutination test was established. It seems reasonable that when animals acquire the disease in the usual manner in infected herds, a like period may sometimes elapse before the fact is revealed by the test. A single test, consequently, cannot always be expected to give the owner of exposed animals definite assurance that they are not in the early stage of the disease.

Even though not perfect, the agglutination test constitutes the most satisfactory means of diagnosis available, from the standpoints of reliability and practicability. The rapid method of application, as developed by I. F. Huddleson and E. R. Carlson, who investigated Bang's disease at the Michigan State College of Agriculture, has broadened the scope of the test. This method permits the test to be read and its results recorded almost immediately after its application.

TREATMENT

Before the true nature of infectious abortions was well understood, it was natural to suppose that medicinal substances could be used to advantage in preventing animals from aborting. This view was so widely entertained and advanced for years that it has been difficult to be thoroughly convinced of its falsity. Testimonials relating to alleged medicinal cures or preventives have sometimes been so extravagant as to be alluring to the discouraged stock owner.

Medicinal substances for the treatment of this disease have gained their popularity, almost if not entirely, because they were used and their value was judged at a time when the disease had run its natural course. The administration of no drug or medicinal compound has proved to be effective in the cure or prevention of this disease.

Treatment in many cases should be given the aborting animal, particularly when there is retention of the afterbirth. Vaginal and uterine douches with nonirritant, antiseptic fluids or solutions of common salt, when properly made, seem to hasten recovery of the generative organs and frequently prevent subsequent barrenness. Treatment of this character, however, should be undertaken with the idea of washing the germs out of the generative organs and relieving inflammation, and not with the expectation that abortion germs will thereby be completely destroyed.

PREVENTION

The dependable information on the disease should be of particular interest and practical value to owners of herds into which the disease has not gained entry. It should not be very difficult to maintain such a herd once it is built up or assembled. Dairy owners who have

recognized the importance of excluding the malady have demonstrated that it can be done.

There are reasons for believing that the disease is most commonly introduced into clean herds through the purchase of cows or pregnant heifers that carry the germs in their bodies. A cow with a calf by her side may be a spreader of the causative germs or may become a spreader later, since it is well known that infection of the afterbirth does not always result in the death of the fetus. Bulls and unbred heifers are less likely to spread the disease and may therefore be added to noninfected herds with less danger.

The feed supply offers another possible agent for spreading the disease. Roughage and grain, if produced on farms where Bang's disease exists, may be soiled with the discharges of infected animals and, when consumed, may transmit the disease. In some instances the infection is probably introduced through a pasture that receives drainage from a farm where the malady is present. There is also the possibility that animals pastured near railroads may be exposed by the scattering of contaminated bedding from stock cars. Unpasteurized milk from creameries or other sources may readily carry the germs to the farms where the milk is used.

It is highly probable, however, that the infected cow or the infected pregnant heifer is mainly responsible for the development of new centers of infection and that excluding them from a noninfected herd would usually mean freedom from the disease.

The serum tests have considerable value in enabling purchasers of animals to distinguish between the infected and the noninfected, but they have their limitations. Difficulties obviously confront the stock owner in keeping his herd free from the disease while adding to it stock from questionable sources.

CONTROL AND ERADICATION

Although the disease may be excluded from noninfected herds with reasonable care, it is much more difficult to eradicate it from infected herds. It is especially discouraging when the disease is running rampant and abortions are occurring frequently. Under these conditions animals may abort unexpectedly in many cases and scatter infectious material over wide areas before being discovered and separated from the rest of the herd. Success in dealing with the problem under these conditions is likely to involve considerable expense. On the other hand, if the disease is more quiescent, and comparatively few abortions occur, the problem of eradication may be greatly simplified.

It is doubtful whether any one method of dealing with infected herds is well adapted to the needs of every herd owner, and will deal satisfactorily with all degrees of infection. Several advantageous methods are, therefore, described.

TEST-AND-SLAUGHTER METHOD

The test-and-slaughter method is similar to the one used so effectively in the eradication of tuberculosis. This method involves the immediate disposal for slaughter of the animals which react to the test, and a thorough disinfection of the stables. In following

this plan it is necessary that repeated tests of the herd be made at intervals of from 30 to 60 days, and that the same disposition be made of any subsequent reactors before they have had an opportunity to abort and spread the infection.

This method may prove costly in herds where the disease is making rapid headway, as the owner may find it necessary to dispose of many more animals than the original test indicated would be necessary. On the other hand, the test-and-slaughter method is likely to be successful and practical in herds having a low percentage of reactors, those in which the breeding or milk-producing value of the animals is not greatly in excess of their value for beef, and in herds in which the disease is only mildly active.

The use of the test-and-slaughter method should appeal also to purebred-stock owners who derive their profits principally from the sale of stock.

TEST-AND-SEGREGATION METHOD

Another method of dealing with infected herds is to subject the entire herd to the agglutination test and segregate the animals into two units occupying different premises. One unit is made up of reactors and the other of nonreactors to the test. This method often appeals to owners who find it impractical to dispose of reactors for slaughter. It can sometimes be practiced at no great additional expense to the owners, and enables them to eradicate the disease more gradually and in such a manner as not to affect profits seriously. The test-and-segregation method is especially appropriate in larger herds which have access to two or more buildings. Although the herd is separated in accordance with the results of the original test, it is necessary that the nonreacting unit be tested at intervals of from 30 to 60 days in order that subsequent reactors may be detected and promptly removed before they constitute sources of infection. A number of tests may be required to detect all the animals that harbor the germ or that acquire the disease.

This plan may be expected to result in a satisfactory increase in the size of the nonreacting unit, since calves may be added from both the reacting and nonreacting units. The success of the method depends largely upon the conditions for so handling the two units as to prevent the transfer of the infection from the diseased to the healthy animals.

The test-and-segregation method is not always practicable for owners of smaller herds. Facilities may not be available, or can be provided only at more expense than seems justifiable, for maintaining such herds on a 2-unit basis. Owners thus situated are inclined to be receptive to the extravagant claims made for alleged abortion remedies and place undue confidence in them.

SANITARY MANAGEMENT

Even though a herd owner is unable to take definite action in eradicating the disease along the lines just described, the situation is not hopeless. There is still another method of control, requiring only a slight outlay, that can reasonably be expected to reduce the losses which the uncombated disease usually exacts. This method is commonly referred to as sanitary management. It is based upon

the idea that benefit can be derived from reducing, even though not totally eliminating, the degree of *Brucella abortus* exposure to which healthy animals in infected herds are normally subjected.

Sanitary management is not very popular since it is a more or less continuous undertaking requiring both vigilance and perseverance. Although it fails to insure freedom from abortion losses it frequently accomplishes highly beneficial results.

As mentioned, some of the known germ-bearing substances expelled by cows and heifers are the fetus, afterbirth, and uterine fluids for a limited period following abortions, and the milk for prolonged periods. The germs are also expelled in the seminal fluid of infected bulls and in the feces of the calves of infected cows. It is also well known that cows that appear to calve normally may expel afterbirths and uterine fluids saturated with the causative germs. Knowledge of these facts, and the fact that animals may readily acquire the disease through the digestive tract, suggests the following recommendations for preventing by sanitary management the spread of the disease in infected herds.

Make frequent observations of all animals for symptoms of aborting, such as swelling of the external genitals or udder enlargement, and when such an animal is discovered place her immediately in a separate stall well away from other stock. If an abortion occurs unexpectedly, isolate the animal in the same manner as soon as the discovery is made. Bury or completely destroy the fetus and afterbirth if the latter has been expelled. Clean and apply disinfectant solutions to areas that may have been contaminated by the abortion products.

Place all pregnant animals in individual stalls a week or 10 days before calving and confine them to their calving quarters for a month following calving and as long afterwards as uterine discharges can be detected.

Clean and disinfect the maternity stalls before placing pregnant animals in them; otherwise they may constitute sources of infection. Avoid carrying germ-laden material from maternity stalls to other parts of premises on hands or clothing. The footwear of the attendant should be well scrubbed with a disinfectant solution after he has been in an infected stall.

Refrain from breeding cows for at least 2 months after calving or aborting. Bulls serving cows after such an interval should rarely if ever acquire the disease thereby or contaminate their generative organs with the causative germs.

Keep aborting animals isolated for a period of from 6 weeks to 2 months. Cows with uterine discharges should always be kept away from the rest of the herd, whether they have aborted or not, until they have recovered.

Dispose of the bedding used by infected or suspected animals in such manner as to render it inaccessible to stock that is free from the disease.

Use care in the management of the bull. Do not permit him to run with the herd or to serve cows on lots that are occupied by stock free from Bang's disease. Although the disease may seldom be transferred by the act of service, the discovery that infected bulls may eliminate the causative germs in their semen makes it plain that

such bulls may be capable of contaminating their environment, which would then become a menace to stock free from the infection. Bulls giving marked reactions to the abortion tests should not be used for service. Even though danger of spreading the disease thereby may be slight, such reactions strongly suggest infection of their generative organs. The reproductive power of such animals may be greatly impaired if not destroyed.

The best results from sanitary management have been derived in those herds to which no cows or heifers other than those produced in the herd were added. There are reasons for believing that the introduction even of animals that have never come in contact with the germs may be a detriment. Such animals may acquire the disease more readily than those raised within the herd, and there is also a strong probability, when highly susceptible animals become infected and abort, that their products of abortion are more heavily infected with the causative germs than are the same substances from animals that may have previously developed some degree of resistance to the malady. These factors, in all probability, are responsible for some of the discouraging results obtained by those who have endeavored to control the disease in their herds while adding to them by purchase rather than by developing their own stock.

HANDLING YOUNG STOCK IN INFECTED HERDS

The care of the growing stock in infected herds is important. The germs are not known to localize in the bodies of young calves. When calves harbor the infection in their bodies at birth it is usually overcome in a reasonably brief period. Heifers, as they approach breeding age when running with infected cows, occasionally acquire the malady, and after conception the danger is increased to a marked degree. Better results consequently may be expected when heifers are separated from the infected stock during their first pregnancy.

VACCINATION

There are certain infectious diseases to which domestic animals become resistant after sustaining one attack. This acquired resistance is commonly referred to as immunity. In some diseases investigators have learned to impart such or similar resistance in an artificial manner so that the animal acquires the resistance without suffering an attack of the disease. Much experimental work has been directed toward devising a successful method of producing immunity against Bang's disease.

Vaccines, bacterins, and serums have been used. Abortion vaccine contains living abortion germs; abortion bacterin, the germs which have been killed; and abortion serum, the fluid portion of the blood of animals that give a marked reaction to the abortion tests. The customary practice is to inject one of these substances beneath the skin of the animal that is to be rendered immune.

Numerous investigators who have studied the value of these substances have arrived at the conclusion that the benefit derived from the use of bacterin and serum is not sufficient to compensate for the labor and expense involved in their administration. Abortion vaccine, on the other hand, has yielded encouraging results and may have considerable practical value in combating the malady.

The results of earlier experiments indicated that when abortion vaccine was administered to unbred stock the living abortion germs which it contained did not long remain active within the animal. Later experiments revealed that although the germs rarely became established in unbred, vaccinated heifers, they occasionally invaded the udders of unbred, vaccinated cows. These infected cows eliminated the abortion germs in their milk.

In an endeavor to overcome this objectionable feature, experiments have been conducted in which vaccines prepared from *Brucella abortus* strains of reduced virulence were used. In addition to the effects of vaccination in connection with unbred heifers and unbred cows that received the vaccine at least 2 months before their breeding, the effects of vaccinating calves from 4 to 8 months of age have also been investigated. The results of these investigations have thrown additional light on the subject of vaccination.

There is evidence to indicate that vaccine prepared from *Brucella abortus* strains of low virulence, whether administered to unbred, sexually mature cattle, or during calfhood, greatly reduces the danger of establishing the infection in them and at the same time affords a serviceable degree of resistance against the disease.

Since abortion vaccine contains the living causative germs, it should never be used except in herds where the disease is definitely known to exist; otherwise new centers of the infection may be established. Pregnant animals should never receive abortion vaccine of the kind prepared at present, since it would be likely to transmit the disease to them rather than act as a preventive. It seems advantageous to refrain from breeding vaccinated animals for at least 2 months after the vaccine has been administered.

Vaccination is by no means a solution of the problem of abortion control. Little or no evidence has been obtained indicating that it benefits animals which have already acquired the disease and are carriers of the causative germs. There are, moreover, reasons for believing that the animal which has sustained an attack of the disease but is no longer a carrier is more resistant to reinfection than she could be rendered by vaccination. Thus the usefulness of vaccination may be limited to animals which, up to the time of treatment, have escaped the disease or that give negative results to the abortion tests. Vaccination seems to be a more appropriate treatment for unbred heifers than for unbred cows, not only because of their tendency to resist permanent infection more successfully but also because unbred heifers, even though raised in an abortion environment, rarely give evidence of having contracted the disease.

Since the use of abortion vaccine seriously complicates the interpretation of the agglutination test of animals, its use in herds is not desirable until all intention of making use of the test-and-slaughter or test-and-segregation methods is abandoned. The use of abortion vaccine furthermore is objectionable in dairy herds where the dairy products are not pasteurized, because of the human-health aspect of the problem.

The immunity that may be imparted by vaccination has not given evidence of always being sufficient to afford complete protection against the disease. Therefore sanitary management should be practiced when efforts at immunization are attempted.

RETAINED AFTERBIRTH

Retention of the afterbirth is a common condition in herds where Bang's disease prevails. Owners are frequently at a loss to know what to do when this occurs. Since the afterbirth of healthy animals often is not expelled until after a few hours, owners are justified in viewing its retention with little alarm until 24 hours after the act of abortion or parturition, provided the animal appears to be normal otherwise. Retention of the afterbirth longer than 24 hours signifies that inflammation of the uterus may be present and responsible for its adherence. When the afterbirth has been retained for 2 or 3 days its putrefaction usually becomes marked. In this putrefactive process within the uterus poisonous substances may be generated and absorbed by the animal, causing fever, loss of appetite, and other evidences of severe trouble. Invasion of the blood stream by the bacteria may terminate fatally.

The afterbirth is frequently removed before putrefaction is excessive by reaching into the uterus with the hand and separating as carefully as possible the attached areas and flushing the organ out afterwards with mild antiseptic solutions or warm salt water. A 0.5 percent Lugol's solution[1] is often used for this purpose. Boiled water which has been permitted to cool to body temperature and to every gallon of which one heaping tablespoonful of table salt has been added makes a satisfactory irrigating fluid.[2] The flushing may be done by the use of a soft-rubber tube with a diameter of about half an inch, to which a funnel is attached. The fluid should not be allowed to remain long in the uterus, but should be siphoned out by lowering the external end of the tube when filled with the fluid.

The afterbirth can seldom be removed by hand without causing some injury to the uterine walls, a factor that renders the operation of uncertain value. A putrefactive afterbirth in contact with injured uterine walls may readily be more harmful and more likely to kill the animal than is its contact with an uninjured uterine surface.

A less drastic method is consequently often advisable. This method permits the afterbirth to remain attached to the uterine walls, while by introducing mild antiseptic substances into the uterus the rapid multiplication of germs is prevented until the membranes come away of themselves. Separating the pendent portion of the afterbirth from the retained part about 6 or 8 inches exterior to the vulva is a means of reducing the contamination of surroundings. A dram (level teaspoonful) of iodoform combined with a quart of mineral or olive oil and introduced into the uterus through a rubber tube is recommended. The milk of animals so treated may have an iodoform odor for several days and therefore should not be used for food. Such irrigating fluids as those mentioned for washing out the uterus after removal of the afterbirth by hand may be used, but seem to be less efficient than iodoform and oil. It is seldom advisable to introduce irrigating fluids more often than once a day or once in 2 days. Although animals have been known to retain the afterbirth for as

[1] Lugol's solution of iodine is compounded as follows: Iodine, 5 parts; potassium iodide, 10 parts; and boiled water to make 100 parts. One part of this compound to 200 parts of boiled water makes a solution suitable for uterine irrigation. Lugol's solution may be purchased from any druggist.

[2] A 1 percent solution of common salt in boiled water at body temperature makes a suitable irrigating fluid. A heaping tablespoonful of dry salt weighs approximately 1 ounce, and this quantity in 1 gallon gives the proper strength.

long as 10 days after a single administration of iodoform and oil, as described, they appeared to experience little discomfort or harm.

Retention of the afterbirth is a more serious condition than often realized, since it may be followed by or induce barrenness. Because of this fact the assistance and experience of a qualified veterinarian are highly desirable.

STERILITY (BARRENNESS)

Sterility commonly gives much concern to the owners of herds infected with *Brucella abortus*. Although the abortion germ seems unable to thrive in the uterus of a cow for any great length of time, it seems indirectly responsible for a high percentage of barrenness because it induces in the uterus a condition that invites numerous other types of germs more permanent and destructive. Sterility troubles may logically be expected when cases of retained afterbirths are treated carelessly.

Sterility may result from bacterial infection of the vagina, the uterus, or the tubes that convey the ova from the ovaries to the uterus. Diseased conditions of the ovaries also may interfere with conception or with regular heat periods. Sterility may furthermore be the result of incomplete development of certain of the generative organs. Determination of the cause is not always possible.

Herd owners can prevent the trouble to some extent by limiting the spread of Bang's disease as well as by making sure that all cases of retained afterbirth receive proper attention. Every long-standing case of sterility is a study in itself, and should be intrusted to the care of a veterinarian when the value of an animal justifies such a procedure. Appropriate treatment in individual cases can be determined only after a careful examination of the generative organs. Although it is not always possible to eliminate diseased conditions when they have been found, professional advice on the outlook for recovery is frequently of value to the owner because it enables him to dispose of hopelessly sterile animals promptly.

Failure of cows and heifers to conceive is sometimes the result of their being mated with bulls that are weak sexually. Owners are cautioned against considering cows to be permanently sterile until they have been bred several times to a bull of known fertility, for it is by no means unusual in herds infected with Bang's disease to have cows conceive on the fourth or fifth service, even without treatment.

INFECTIOUS ABORTION IN ANIMALS OTHER THAN CATTLE

Abortion troubles, although of more economic importance in cattle than in other animals, frequently give the owners of horses, sheep, goats, and swine considerable concern.

In horses a germ known as *Bacillus abortivo-equinus*, which has characteristics different from those of *Brucella abortus*, has given evidence of being largely responsible for abortion although in rare instances abortion has been caused by *Br. abortus* (bovine) which commonly affects cattle, and *Br. abortus* (porcine) which commonly affects swine. The type of infectious abortion most common in horses can be diagnosed with reasonable accuracy by means of blood tests. The use of equine abortion bacterin as a preventive agent has given evidence of being beneficial in the control of the disease.

In sheep, a germ called a spirillum or vibrio has appeared to be mainly responsible for abortion losses although abortion outbreaks due to *Br. abortus* or *Br. melitensis* have also been reported in other countries. The disease in sheep does not appear to prevail widely or to be of great economic importance, at least in North America.

Infectious abortion of swine causes serious interference with the swine industry, especially in those sections where hogs are raised in large numbers. It is caused by a germ known as *Brucella abortus* (porcine), which is closely related to *Br. abortus* (bovine), but is not identical with it. Swine can readily be infected with the disease through the digestive tract and are believed to acquire the disease commonly by consuming materials such as fetuses, afterbirths, and uterine discharges, expelled by infected swine.

The act of abortion as a symptom of the disease does not appear to occur so frequently in swine as in cattle, and the disease has shown evidence of being self-limiting to a greater degree in swine than in cattle.

Although the germ which causes the disease in swine is closely related to that affecting cattle, swine have not been shown to contract the disease from infected cattle.

An agglutination test of the blood of swine is a means of detecting the disease in this species. The test has been used to some extent as a basis for control and eradication efforts.

BRUCELLA ABORTUS AND HUMAN HEALTH

Infection of the udders of cows with *Brucella abortus* and the possible presence of the germs in the milk have received more attention during recent years than formerly because of the discovery that the organisms sometimes affect human health.

For several years after it was found that *Brucella abortus* affected cattle and swine, it was generally supposed that no special precautions were necessary to prevent their causing human disease. Experimental studies had strengthened this belief. When it was discovered that *Br. abortus* of both the bovine and swine types was closely related to *Br. melitensis*, the type known to cause disease in both goats and man, investigators suspected that *Br. abortus* (bovine) and *Br. abortus* (porcine) might also produce disease in man. Evidence was not obtained immediately, but in the course of time a few cases of human illness were traced to the effects of *Br. abortus*. Undulant fever, caused by *Br. abortus* (porcine) and *Br. abortus* (bovine) has now been recognized in many sections of the United States and in numerous other countries. Human beings are believed to acquire the disease occasionally when caring for infected swine or cattle, particularly swine. The fetuses, afterbirths, and uterine discharges of affected animals are special sources of danger.

The disease is sometimes acquired by human beings through the consumption of raw milk from cows infected with *Brucella abortus*. Butter made from raw cream produced by infected cows has been known to harbor abortion germs.

Although the danger of contracting the disease through the consumption of dairy products from infected cows seems to be relatively slight, it should not be ignored. Pasteurization, however, renders milk safe for human consumption.

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